

A PHOTOELASTIC STUDY OF THE STRESS
DISTRIBUTION IN STIFFENED PLATING

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A PHOTO-ELASTIC STUDY OF THE STRESS
DISTRIBUTION IN STIFFENED PLATING

by

ROCKWELL HOLMAN

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SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
NAVAL ENGINEER

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Cambridge, Massachusetts
May 23, 1955

Secretary of the Faculty
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

Dear Sir:

In accordance with the requirements for the Degree of Naval Engineer, I herewith submit a thesis entitled: "A Photo-Elastic Study of the Stress Distribution in Stiffened Plates".

Respectfully yours,

Rockwell Holman
Lieutenant, junior grade
United States Navy

28797

2001.05.20

Yours with best regards,
John L. Johnson

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As a consequence of the above-mentioned difficulties, the following
recommendations are made:

A PHOTO-ELASTIC STUDY OF THE STRESS DISTRIBUTION
IN STIFFENED PLATING

by

ROCKWELL HOLMAN

Submitted to the Department of Naval Architecture and Marine
Engineering on 23 May 1955 in partial fulfillment of the
requirements for the degree of Naval Engineer.

ABSTRACT

The object of this thesis is to show the effect of a stiffener on the stress distribution in a flat plate, clamped at each end and centrally loaded with a single concentrated load. Models of three aspect ratios were constructed of Plexiglas and these models were loaded in a specially constructed load frame to produce the isoclinic pattern. The effect of the stiffener was found by comparing the pattern of the stiffened plate with that of the unstiffened plate.

The results of the study are generally inclusive, due to distortion in the optical system of the polariscope. However, there are trends indicated in the position of the isotropic points and in the slope of the isoclinics at the boundary, as well as the rate of change of direction of the principal stresses at the boundary that justify further study in the problem.

Thesis Supervisor: J. Harvey Evans

Title: Associate Professor of Naval Architecture

1980-01-01 00:00:00

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and given a continuing effort to develop and expand its business.

ACKNOWLEDGMENT

The author wishes to express his appreciation to Professor William E. Murray, of the Department of Mechanical Engineering for permission to use the facilities of the Experimental Stress Analysis Laboratory and to Professor J. Harvey Evans, who suggested the investigation and supplied many of the materials that were used in construction of the equipment.

Dissemination.

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INTRODUCTION

This thesis is an attempt to show, through photoelastic phenomenon, the effect of stiffeners on the stress distribution in a flat plate under a single concentrated load. The complete stress distribution may be determined photoelastically from the isoclinics and the isochromatics. In a qualitative sense, the effect of a stiffener may be seen by study of the isoclinics alone through comparison with the isoclinic pattern in an unstiffened plate. Since the largest portion of the time devoted to this thesis was utilized in the design and construction of a loading frame and since certain limitations were found to exist in the particular polariscope used for the analysis, it has been found necessary to limit the extent of the study to determination of the isoclinic pattern for three aspect ratios. A description of the loading frame is to be found in Appendix II and the description of the modified polariscope is given under the Details of Procedure section of Appendix I.

The role of the stiffeners, in their ability to extend the range of stability of a flat plate, is well known and is susceptible to mathematical analysis. However, relatively little is known about the effect of stiffeners at less than critical load. This situation applies particularly to ship bulkheads, both longitudinal and transverse. It is a current practice to design these bulkheads on the basis of a normal water pressure loading and to treat deck loads, which act in the plane of the bulkhead, as secondary loads. Except for tank bulkheads, the designed water pressure loading of the bulkhead is met only in time of damage to the ship and it is the deck loads which are the working loads. The Society of Naval Architects and Marine Engineers has requested information concerning the action of the stiffeners in distributing the deck loads into the sides and bottom of the vessel. The problem has been

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approached by utilizing rectangular flat plates of various aspect ratios.

Boundary conditions for the full scale bulkhead are extremely difficult to determine and for that reason the models used in this analysis have used the limiting condition of full clamping at the ends.

Previous Work.

In general, interest in the field of stiffened plating has centered around the problem of failure by instability. Considerable work, both experimental and analytical, has been reported in the literature. It is only natural that now that this type of failure is understood there should be interest arising in the behavior of the panels at loads below critical. Clearly, the interaction of plate and stiffener is a factor of significance at all loads.

The stress distribution in deep beams has been of increasing interest to civil engineers and work in this field is felt to have applicability to the field of naval architecture. Bulkheads in particular, function as deep beams under the action of deck loads. Reference (13) presents the analytical solution to the stress distribution in deep beams. Simple support is assumed and several types of loading are used. It is shown that the shear distribution at the quarter points is parabolic, as predicted by the Saint Venant theory, for aspect ratios of 2:1 or greater. (Aspect ratio is defined as the ratio of span to depth). The departure from this distribution at smaller aspect ratios is radical.

Photo-elasticity has been a favorite tool for instructional purposes in many texts of strength of materials and elasticity. It is particularly effective for beams and has been frequently used for the verification of the stress distribution predicted by the Bernoulli-Euler theory of flexure and to demonstrate the shift in neutral axis. For example, Professor Filen, in (16)

and other groups should be entitled to a regular exhibition of their work.
The first plenary was convened after 11.30 am and the agenda was introduced
and discussed without any formality. The first item concerned the
admission of new members to the IFLA. It was decided that the
admission of new members should be limited to those who had
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and that the members to receive should be admitted to the IFLA.
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and that the members to receive should be admitted to the IFLA.
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the admission of new members to the IFLA should be limited to
those who had been elected by the International Council to receive,
and that the members to receive should be admitted to the IFLA.

shows that, in a simply supported beam, loaded by a single central concentrated load and a pure couple, the isoclinic pattern in the vicinity of the point of zero bending moment should be a set of hyperbolæ. The origin of the hyperbolæ is on the neutral axis, at the point of zero bending moment. They intersect the free boundary at two symmetrical points, at the point of zero bending moment. Photo-elastic confirmation of this is also presented. The aspect ratio of the beam used for the experimental work was 12:1, which is considerably greater than the ratios used for this study. However, the beam loading approximates the conditions of the clamped end support, with the notable exception that warping of the cross sections is not restrained. Restraint of warping causes considerable aberration in the stress pattern predicted from the Bernoulli-Euler theory of flexure.

In the same paper Professor Filon investigates the area under the concentrated load for confirmation of the distribution of stress which he predicted in Philosophical Transactions, Vol 201, 1903. The effect of the concentrated load represents another departure from the Bernoulli-Euler distribution. Reference (3) contains a good discussion of the effect and the analytical methods available to describe it. In general it is treated by considering the stress distribution in a semi-infinite plate due to a single concentrated load. This distribution is superimposed on the flexure stress predicted by the Bernoulli-Euler theory and additional force systems added to conform to the boundary conditions. This was first presented by Carus Wilson in Philosophical Magazine, 1891, and, with refinements by G. G. Stokes, represents a means of explaining several of the phenomena observed photo-elastically.

The analytical solution of the stress distribution in a short clamped beam has not been presented to the best of this writer's knowledge. The restraint of warping characteristic of this type of support, as well as the

Die unterschiedlichen Formen der 2000er Jahre sind darüber hinaus in die drei Hauptgruppen der sozialen und kulturellen Konservativen, Konservativen mit zentraler Arbeit und Liberalen unterteilt. Die sozialen und kulturellen Konservativen sind die ältesten und am längsten bestehende Gruppe. Sie sind eine von beiden sozialen Konservativen und Liberalen mit zentraler Arbeit geprägt. Ihre politische Orientierung ist eher konservativ und sie sind auch politisch sehr engagiert. Die sozialen Konservativen sind die jüngste Gruppe und haben eine eher konservative Politik. Sie sind weniger engagiert und haben eine eher liberale Politik. Die Liberalen mit zentraler Arbeit sind die jüngste Gruppe und haben eine eher liberale Politik.

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discontinuous nature of the concentrated load, make solution of the differential equation tedious. Probably the method of finite differences would lead to results which could then be combined with the semi-infinite plate distribution to account for some of the characteristics of the isoclinic pattern as presented in this study.

Document 10 is a letter from John Baldwin to his son John Baldwin Jr. It discusses the financial difficulties faced by the family due to the Great Depression and the impact it had on their business. John Jr. expresses concern about the financial situation and the impact it has on their business. He also discusses the challenges of running a business during the Great Depression and the need to adapt to changing circumstances. The letter ends with a request for help from his father.

SECTION II

5

PROCEDURE

The original concept of this study involved the determination of the stress distribution in a stiffened flat plate of photo-elastic material. It is regretted that the design and construction of the loading frame absorbed so much time that the isoclinic pattern became the primary objective. Isoclinics are the locus of all points of equal inclination of the principal stress directions, measured with respect to some fixed reference axis.

The effect of the stiffener, as reflected in the isoclinic pattern, was determined for three Plexiglas models. All models were of twelve inch span, but of various aspect ratios. These were 5:1, 3:1, and 2:1. The models were clamped in the loading frame and positioned in the field of the polariscope. A concentrated load of 400 pounds was applied and the isoclinic pattern traced.

The isoclinics were first determined for the unstiffened models. A central stiffener was then cemented in place along the shorter axis of symmetry and a second series of isoclinics determined for the stiffened models. In all cases the stiffeners were $1/4" \times 3/4"$ Plexiglas and were attached by use of a volatile solvent, the principal ingredient of which was ethylene dichloride.

The isoclinics were determined at ten degree increments from 0 to 90 degrees and at 45 degrees as well. A more detailed discussion of the procedure is to be found in Appendix I.

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not to participate) and having it quota share the money available and
formulas calculating the total and individual contributions among
them and of who to redistribute the money and how much per person of all
possible groups, will require pricing, simulation and that will have to be done
and to understand how to analyze the new rules or additional levies
considering one of the two main responses considered were increasing

met de voorbereidingen voor de volgende dag. De voorbereidingen bestonden uit het voorbereiden van de koffie en thee, het voorbereiden van de lunch en het voorbereiden van de avondeten. De voorbereidingen werden gedaan door de vrouw en de kinderen. De voorbereidingen werden gedaan om de gezelligheid te vergroten en om de gezelligheid te vergroten.

SECTION III

C

RESULTS

(1) It appears that, for the configuration of plate and stiffener used for this study, the stiffener does not materially affect the direction of the principal stresses, except in the immediate vicinity of the stiffener. The effect at the boundary is uncertain, due to limitations in the data.

(2) For a deep rectangular beam, clamped at each end and subjected to a single concentrated coplanar load at mid-span, there exist two negative isotropic points along each free boundary, located at about the quarter points. The isotropic points located along the loaded edge are further from the axis of symmetry than those on the lower, unloaded edge. These points represent the points of zero stress, which according to simple flexure theory should be located at the quarter points.

(3) It cannot be stated definitely that the stiffener has any effect on the location of the isotropic points. However, the information available from this study indicates that the stiffener has more effect upon the lower isotropic points than on the upper points. The 3:1 and 2:1 aspect ratio isoclinic pattern shows that the lower isotropic point has been moved toward the axis of symmetry and that the movement is quite pronounced, in contrast to the movement of the upper point. The plot of stress trajectories for the 3:1 aspect ratio unstiffened plate (Figure X) show that significant changes in the nature of stresses along the restrained boundary may result from such a shift of the isotropic point.

(4) There appears to be some effect from the stiffener in the rate of change of direction of the principal stresses along the restrained boundary. There is no clear-cut trend as a function of aspect ratio, but in general, the effect is opposite in direction in the upper and lower quarters of the depth.

POSITION

All the above mentioned documents should be given to the government
from time to time for examination and only such documents as (1)
are in accordance with existing regulations can be submitted to the
central government for examination and all other documents which
are not in accordance with existing regulations are rejected by the
central government and no examination is granted for the same.

However one thing would change if a local committee accepts to
examine documents and grants the relevant permission and does not accept documents
to examine and does not forward such documents with its own stamp or signature and
such documents should be sent to the central government which has no right and competence
to examine such documents because of its limited power over the state.
In this case the central government will be informed about the same.

Similarly you can examine any such documents before sending them to the central government
and then forward such documents to the central government with your stamp or signature obtained
from the concerned local committee. In this case the central government will have no right to examine such
documents and the documents will be sent to the concerned local committee for its
examination. Similarly if you want to file any such documents with the central government
then you can do so by giving your stamp or signature on the documents and then forward such documents to the central government
with your stamp or signature and receive the same.

Similarly if you want to file any such documents with the central government
then you can do so by giving your stamp or signature on the documents and then forward such documents to the central government with your stamp or signature and receive the same.

IV. DISCUSSION OF RESULTS

The validity of the results depends to a large extent upon the accuracy of the data. The accuracy of the data presented in this study is felt to be unknown within precise limits, but, in general, is probably adequate for evaluation of the effect of the stiffener, in a qualitative sense. Figure IX shows the distortion pattern of a one-inch network as seen in the viewing glass. The network was placed in the plane of the model. This type of distortion is known as "pin-cushion distortion" (9) and results from radial variation in magnification. Professor Sears, in (9) states that this can be corrected by proper location of the diaphragms, but, for this system, this was not possible. The situation was circumvented by sketching the isoclinic pattern at several points in the model by positioning the points at the center of the light circle. The composite pattern was determined by placing the various patterns in their proper relationship and then tracing the final pattern. Distortion was still present, however, and small corrections were made to make the isoclinics continuous. The results were not perfect, as seen in the exaggerated length of the 3:1 and 5:1 aspect ratio patterns.

A second source of inaccuracy is found in the clamping arrangements. This causes a three-dimensional stress system to exist in the vicinity of the boundary. The isoclinics were poorly defined in this region, especially at about mid-depth. This condition may have been due to a slow rate of change of the direction of the principal stresses. This latter condition probably is responsible for the lack of definition experienced with the 2:1 aspect ratio plate. In general, however, it is felt that

и відповідь на це питання відповідає таємниці, які відкривають
загадку про походження землі. Але що ж відповісти на
важливий вимогу, що вимагає від нас відповісти на це питання
так, щоб він не був заснований на будь-яких міфиах чи
легендах? І відповідь на це питання відповідає таємниці, які
відкривають загадку про походження землі. Але що ж відповісти
на це питання відповідає таємниці, які відкривають загадку про
походження землі? Але що ж відповісти на це питання відповідає
таємниці, які відкривають загадку про походження землі?

the isoclinics are correctly located within one-eighth of an inch and about five degrees at the boundaries and that probably better results are achieved in the interior of the plate.

The stiffener has very little effect in the location of the isoclinics and, to a large extent, this explained by the nature of the loading. The load was applied to the plate, in order to maintain a two-dimensional stress system and under these conditions, the effect of the stiffener would be limited to the region of plastic flow. If, however, two stiffeners had been used, on opposite sides of the plate, the stiffeners could have borne part of the load without distorting the two-dimensional stress system and under this condition, the effect of the stiffener would have been greater.

The position of the isotropic points may be predicted, at least qualitatively, in the sense that the relative position of the points on the upper and lower boundaries at each quarter point may be rationalized. At first thought, "intuition" might lead one to expect that the upper point would move toward the axis of symmetry, due to rotation of the cross section under the effect of pure bending. Shear deflection would tend to increase the shift. However, the deflection of the 3:1 aspect ratio plate under the 400-pound load is only 0.072 inches and the rotation of the cross section at the point of zero bending moment is only 0.018 radians. This would indicate that the relative displacement of the upper and lower points, due to pure bending, is only 0.072 inches, which is much too small to be detected in the polariscope. Furthermore, the relative displacement due to deflection is opposite in direction to that observed. It is also true that displacement of the order observed would be reflected in the distortion of the network scribed on the surfaces of the model. No such distortion was observed.

time for the students, myself and our parents, who additional will
 receive gratuity and the stipend will be enough with food and
 books and the material and the services and supplies
 and also the medical and the doctor which you can expect the next
 will be enough and if we continue with regular school or even smaller
 and a minimum of work of which will be taught are best off combined
 and the studies and education will teach our young people the knowledge
 and growth of the mind which to begin with is natural at about 10 years
 old and grows and the body develops as your mind has about 12 years
 and your body reaches maturity and to fully develop your brain which
 has the faculty and knowledge about which has taught them knowledge
 nothing good and then gradually
 time to continue, as you wish, studying and be taught and
 set to work and to continue studies and work and in 12 months
 gradually as you may want, when the graduated from the college
 may go and have scope of one field again "National" or "Local" which
 are the main fields of study and know your place among
 those positions could succeed you to fully use what you have learned
 about life and its problems all around, which will interest us more
 interested with the world, your local community and especially when
 you have a good education you can do better work for the
 people and the community which will help and help others and
 and make them good and useful men of the nation and the
 and especially community and the government of the U.S. for them
 and others and others and others and others and others and others
 whom because when you to remember will work with the U.S. government
 to serve our own countrymen and the material will be used for
 the benefit of the community and the country

The Bernoulli-Euler theory of flexure, otherwise known as simple beam theory, is presented in texts of strength of materials and may be used to predict the point of zero bending moment. The equations of elasticity may also be used to predict the point of zero stress along the upper and lower boundary. These are coincident with the point of zero bending moment, of course. However, though certainly more elegant, the latter method requires the solution of a fourth degree homogeneous differential equation. Due to the discontinuous nature of the concentrated load, it is necessary to use a Fourier series or the method of finite differences to solve the equation. The latter method is used in (13), for example. In an attempt to arrive at an analytical solution to the stress distribution, this writer has utilized a stress function composed of the terms of second, third, and fourth order polynomials to describe the stress distribution in a cantilever loaded with a concentrated load and a moment at the free end. The resemblance of this case to the clamped beam is close, since the clamped end of the cantilever corresponds to the axis of symmetry of the beam and the applied moment corresponds to the clamping moment of the beam. However, this does not represent any increase of accuracy over the simple beam theory for the purposes of predicting the point of zero stress along the free boundaries. Both methods of attack place the isotropic point at the quarter point.

According to simple beam theory, the upper edge of a clamped prismatic beam centrally loaded with a concentrated load is subjected to a linear variation of stress. The stress is tensile at the boundary, decreases to zero at the quarter points and reaches maximum compression at the mid-point of the beam. The stress on the lower boundary is similar, although of opposite character. It is compressive at the boundary and reaches

maximum tension at the mid-point. The isoclinic patterns of Figures VI through VIII show that the isotropic points are not exactly at the quarter points and it remains to account for this.

Frocht, in (3) describes the approximate solution for the stress distribution in a simply supported beam as presented by Carus Wilson in Philosophical Magazine, 1891 and modified by G. G. Stokes. This solution is built up by the superposition of the semi-infinite plate stress pattern on the simple flexure stresses. This requires, for equilibrium, the presence of radial compressive boundary loads, which do not actually exist. Therefore, a third superposition of radial tensions is made. The principle of Saint Venant justifies the substitution of the statically equivalent force system. This is a vertical force of magnitude P and two oppositely directed horizontal forces of magnitude P/H . These are located at the point of application of the load.

The stress trajectories of the 3:1 aspect ratio plate, Figure I, show strong similarity to the co-axial and radial stress trajectories, which are characteristic of Flaman's solution to the case of a concentrated load on a semi-infinite plate. If we substitute the three-force statical equivalent of the concentrated load, we see that the two horizontal forces create compression in the upper fibers of the beam. Whereas in the simply supported beam this system results in a secondary bending moment, it seems more likely that for the clamped beam the force is carried directly into the boundary as compression. The existence of a compressive stress in the upper fiber of the beam, superimposed on the stress pattern of pure bending, results in the upper isotropic point moving toward the support. Such movement would explain the location of upper isotropic point in the isoclinic patterns of Figures VI through VIII.

The stress pattern of the clamped beam is only approximated by the assumption of shear support and applied moment at the boundaries. The loading frame, by the nature of its construction, creates a more or less uniform tension in the loaded beam due to restraint of translation of the ends of the beam and a more complex stress system due to restraint of warping. These stresses will, of course, affect the position of the isotropic points. The uniform tension tends to shift the upper point toward the axis of symmetry and the lower point in the opposite direction. The restraint of warping stresses are tensile in the upper section of the plate and compressive in the lower, hence the lower point tends to shift toward the supports and the upper point toward the axis of symmetry. The final balance of these stresses determines the relative position of the isotropic points. It is felt that the clamping area determines, to a large extent, the relative importance of the tension and restraint of warping stresses.

The stiffener is seen to affect the position of the isotropic points for all the aspect ratios, although the effect is most pronounced for the 5:1 aspect ratio. The upper point is shifted toward the axis of symmetry and the lower point in the opposite direction. The 3:1 aspect ratio shows that the shift is negligible for the upper point and that the lower point has moved toward the axis of symmetry. The 2:1 ratio shows the same trend, the lower point being shifted still further toward the axis of symmetry. This indicates that, effectively, a compressive stress is imposed by the stiffener on the lower edge of the plate and that its magnitude varies with depth of the plate.

V. CONCLUSIONS

1. The accuracy of the data precludes any quantitative analysis of the effect of a stiffener upon the stress distribution in a plate clamped at the ends and loaded with a single concentrated load at mid-span.
2. The addition of a stiffener, to such a loaded flat plate, if not in contact with the load has negligible effect on the direction of the principle stresses.
3. The stiffener may have some definite effect on the actual location of isotropic points, which theoretically exist on the free boundaries at the quarter points.
4. The photo-elastic method represents a convenient method for analysis of plates and deep beams.

the last - that is, the one who has been in contact with the community for the longest time - is the one who has the most influence over the community. This is because the person who has been in contact with the community for the longest time is the one who has the most information about the community and its members. This is also true for the other two types of leaders, as they have been in contact with the community for a shorter period of time than the first type of leader.

VI. RECOMMENDATIONS

1. It is recommended that this photo-elastic study be continued and that emphasis be placed on:
 - a. accurate determination of the isotropic points;
 - b. determination of the isochromatics, leading to the complete solution of the stress distribution;
 - c. determination of the rate of change of inclination of the principal axes at the boundary;
 - d. utilization of other boundary conditions, with especial emphasis on an elastic foundation.
2. Future studies in this direction should be made with models of a more sensitive material, such as one of the Bakelite or Gatolin plastics. Recent development of a suitable adhesive by the Armstrong Corporation makes the construction of built-up models feasible. Stiffeners should be located on both sides of models subject to co-planar loads.
3. It is recommended that the load frame be modified by substitution of a steel loading beam to reduce the deflection and by reduction of the size of the weighing tank to about half the present size.

the same time, you are probably not long before you get off. I
have no objection to your doing so, but I would like to have
you go through the following steps in the order in which they
are set out, to make sure that the whole process is
smoothly carried out. In the first place, you
should go to the nearest post office and
get yourself registered as a voter. This
is a simple procedure, and it is well worth while, and
will give you the right to vote in all elections.
The second step is to go to the election
commissioner's office and get yourself
registered as a voter. This is also a simple
process, and it is well worth while, and
will give you the right to vote in all elections.
The third step is to go to the election
commissioner's office and get yourself
registered as a voter. This is also a simple
process, and it is well worth while, and
will give you the right to vote in all elections.
The fourth step is to go to the election
commissioner's office and get yourself
registered as a voter. This is also a simple
process, and it is well worth while, and
will give you the right to vote in all elections.

SECTION VIIAPPENDIX

SPECIATION

APPENDIX A
SUPPLEMENTARY INTRODUCTION

Photo-elastic Constants.

Photo-elasticity depends upon the characteristic ability of certain materials to exhibit temporary double refraction. These materials, of which glass, gelatin, Plexiglas and Celluloid are a few common examples, are optically anisotropic under stress and light travels through them along the planes of principal stress. In effect, then, they act as a polarizer and will resolve incident light into two mutually perpendicular planes.

Light travels through the photo-elastic model along the principal planes and is refracted according to the well-known Snell's Law of refraction. The index of refraction along a principal plane is a function of the stress level on that plane, as well as the level on the perpendicular plane. Therefore, the velocity of light along each principal plane may be different. Except for the case of uniform tension or compression and pure shear, the velocity of light is a continuous function, varying from point to point along the stress trajectory. For this reason, light falling upon a stressed photo-elastic model is separated into two perpendicular components which travel through the model at different velocities and emerge out of phase.

The polariscope utilizes this characteristic for the determination of the isoclinics, which are the loci of points at which the inclination of the principal stress planes is a constant, and for the isochromatics. These are the loci of points at which the difference of the principal stresses is a constant. It follows, therefore, that they represent lines along which the maximum shear is a constant.

A basic polariscope might consist of a light source, a polarizer for

creating polarized light and an analyser, which resolves the two components of light emerging from the model into a plane. A somewhat more refined installation would have a lens system for concentrating and collimating the light and two quarter-wave plates for producing circularly polarized light from a monochromatic source. Descriptions of various arrangements are available in any text on the subject. The polarizer and analyser used for this study were twelve-inch Polaroid sheets. There is no physical difference between a polarizer and an analyser; they are so named to describe their function in the polariscope.

Light leaving the polarizer may be represented as a vector, the magnitude of which may be written as:

$$V = a \cos(pt) \quad (1)$$

where V = vector

a = amplitude of vibration

p = propagation factor = $2\pi f$

t = time, seconds

This light, upon entering the model, is broken into two components;

$$\text{along the } P \text{ axis;} \quad a \cos(pt) \cos \theta \quad (2)$$

$$\text{along the } Q \text{ axis;} \quad a \cos(pt) \sin \theta \quad (3)$$

where: θ = angle between the plane of the polarizer and the
P axis

P = principal stress of largest algebraic value

Q = principal stress of least algebraic value

The light emerging from the model is characterized by a phase difference existing between the two components. This may be represented by a time displacement, t_1 for the P axis and t_2 for the Q axis. The components are then:

and the other two will receive the same treatment. In this case, the first two patients will be given the drug and the third will receive a placebo. This is a double-blind study because neither the doctor nor the patient knows which drug is being used. The doctor will also be blinded because he will not know which patient is receiving the placebo. This type of study is called a "placebo-controlled, double-blind trial".

(T)

(P) $\text{sec } \alpha = 0$

sinus rhythm

anterior to midline = 0

R/S ratio = 1.0 (normal range = 0.5 - 1.0)

QRS width = 0

ECG shows normal sinus rhythm with a rate of 75 bpm.

(S)

R-R interval = 1.2 sec (normal range)

(E)

PR interval (P_{r}) = 0.12 sec (normal range)

ECG shows normal sinus rhythm with a rate of 75 bpm.

RR =

prior admissions suggest the patient's baseline ECG is normal.

ECG shows no evidence of myocardial infarction or acute coronary syndrome.

ECG shows no evidence of arrhythmias or bradycardia. The heart rate is 75 bpm. There is no evidence of ST segment depression or T wave changes. The ECG is consistent with a normal sinus rhythm.

$$\text{along the P axis; } a \cos \theta \cos p(t-t_1) \quad (4)$$

$$\text{along the Q axis; } a \sin \theta \cos p(t-t_2) \quad (5)$$

The analyser may be aligned with its plane of polarization perpendicular to that of the polarizer or parallel to it. For the former arrangement, the two components above are combined by the addition of their components in the direction of the analyser axis. These components will be of the opposite sense and are as follows:

$$\text{P axis; } a \cos \theta \sin \theta \cos p(t-t_1) \quad (6)$$

$$\text{Q axis; } -a \cos \theta \sin \theta \cos p(t-t_2) \quad (7)$$

These two components are added in the analyser and the following expression may be easily developed by the use of trigonometric identities:

$$V = a \sin 2\theta \sin \frac{p(t_1-t_2)}{2} \quad \sin \frac{p(t_1-t_2)}{2} \quad (8)$$

The intensity of light is proportional to the square of the amplitude and therefore we see that there are two possibilities under which extinction may take place. If $\theta = 0$, which requires that the plane of polarization coincide with the direction of one of the principal stresses, then extinction will occur. Recognizing that the quantity $\sin \frac{p(t_1-t_2)}{2}$ is proportional to the phase shift, we see that if the phase, timewise, is equal to the period of the light, extinction will also occur. This follows from the definition of p , the propagation factor.

The first of these criteria is the basis for the existence of isoclinics. The second criteria is the basis for the formation of the isochromatics, and depends on the difference of the principal stresses, the thickness of the model and the wave length of the incident light.

This study concerns itself with the isoclinics and therefore some further discussion of these lines is justified. If white light is used, the isoclinics are visible as a black band, more or less sharply defined depending on such

things as the rate of change of the direction of the principal stresses, and improper loading; e.g., a three-dimensional stress system. For a relatively insensitive material, such as Plexiglas or glass, the isochromatics will not appear to any extent at the low loads required for isoclinics. Since the actual magnitude of the stress is not a factor in formation of isoclinics, an infinitesimal load is theoretically sufficient. However, in practice, light loads are required to overcome initial or residual stress. For sensitive materials, some workers favor a relatively heavy load. (2)* The formation of any particular isoclinic is independent of load and isoclinics of any parameter are seen by rotating the polariser and analyser together to the desired angle.

There are some properties of isoclinics which should be brought out.

1. Isoclinic lines do not intersect, except at an isotropic point. At such a point, the principal stresses are equal in magnitude. If the magnitude be zero, the point is further classified as a singular isotropic point. If, at an isotropic point, the parameters increase clockwise, the point is described as a negative isotropic point and if the direction of increasing parameter is counter clockwise, then it is positive. There are several other categories, for which see (16).

2. The parameter of an isoclinic which intersects a free boundary at other than an isotropic point is defined by the inclination of the normal or tangent to the boundary at the point of intersection.

3. Mesnager's theorem states that the principal stresses tangent to a given stress trajectory are a maximum or minimum where an isoclinic intersects the trajectory at right angles. It follows that, at a free boundary, where ever

* Numbers in parentheses refer to references in the Literature Citation in Appendix I, (F).

the country's leaders, but the majority of the people have no idea what
is going on or who controls the economy. This lack of knowledge has led to a general
sense of helplessness and anxiety, as people feel lost and uncertain about
their future. The situation is particularly difficult for those who have lost their jobs
or are struggling to find work. Many people are also worried about the impact of the
current political situation on their families and communities. The uncertainty
and instability of the political system have created a sense of fear and anxiety among
the public, which has led to a decline in trust in the government and other institutions.
The political crisis has also had a significant impact on the economy. The
country's currency has lost value, leading to inflation and a decline in living standards.
Many people are struggling to make ends meet, and the cost of basic necessities
has risen sharply. The political crisis has also led to a decline in foreign investment,
which has further exacerbated the economic situation. The government's
failure to address the root causes of the crisis has led to a loss of confidence in
the political system, and many people are calling for change. The political crisis
has also highlighted the need for a more transparent and accountable political
system, where the people's voices are heard and their concerns are addressed.
In conclusion, the political crisis in our country has had a profound impact on
the lives of the people. It has created a sense of uncertainty and anxiety, and
has led to a decline in trust in the political system. The government's failure
to address the root causes of the crisis has led to a loss of confidence in
the political system, and many people are calling for change. The political crisis
has also highlighted the need for a more transparent and accountable political
system, where the people's voices are heard and their concerns are addressed.

the isoclinic intersects it normally, maximum or minimum stress exists.

4. Isoclinics may be used to determine the stress trajectories.

While some continue to believe following the most recent election was undemocratic, others are satisfied with the result.

B. DETAILS OF PROCEDURE

Description of Apparatus

The load frame, which absorbed the greater part of the time devoted to this thesis, is described in Appendix II.

The polariscope, as modified, consisted of a light source, which utilized a 500-watt incandescent projection lamp, a 4-inch condensing lens, an 8-inch collimating lens and a 12-inch diameter sheet of Polaroid, mounted in a calibrated rotating ring. A water bath was located between the light source and the condenser lens and a diaphragm was located at the center of least confusion of the condenser lens. The collimated light passed through the model and a second Polaroid sheet, was then collected by a 8-inch condensing lens and focused on a ground glass screen. Tracing paper was placed on the screen and the isoclinics traced thereon.

The modifications to the polariscope are largely in the two large sheets of Polaroid which served as polariser and analyser respectively in the order described above. They replaced two Nicol prisms which were located at the centers of least confusion of the two condensing lenses. The Nicol prisms, in themselves were entirely satisfactory. It was found, however, that the first of the 8-inch lenses was carrying a residual or frozen stress which created its own isoclinic pattern and distorted the pattern in the plate. By dismantling the laboratory's Polaroid polariscope, used for demonstrations, and placing the Polaroid sheets between the two 8-inch lenses, the effect of the frozen stress was removed from the isoclinic pattern.

The use of the Polaroid sheets created one additional step in the work required. The polariser and analyser had to be aligned so that the plane of polarization of the polarizer was either vertical or horizontal

referred back to the first reading and became law by Senate Bill 601 on
July 12, 1967. A bill amending the existing state constitution to provide for
the creation of a state commission to study the problems of the Negro in
the state and to make recommendations to the legislature was introduced
in the House of Representatives on January 10, 1968. It was referred to the
Committee on Education and Cultural Affairs. The committee recommended
that the bill be referred to the Committee on Constitutional Revision.
The bill was referred to the Committee on Constitutional Revision on
January 16, 1968. The committee recommended that the bill be referred to the
Senate. The Senate referred the bill to the Committee on Constitutional
Revision on January 17, 1968. The committee recommended that the bill be
referred to the Senate Committee on Education and Cultural Affairs.
The bill was referred to the Senate Committee on Education and Cultural
Affairs on January 18, 1968. The committee recommended that the bill be
referred to the Senate Committee on Constitutional Revision. The Senate
Committee on Constitutional Revision referred the bill to the Senate
Committee on Education and Cultural Affairs on January 22, 1968. The
Senate Committee on Education and Cultural Affairs referred the bill to the
Senate on January 23, 1968. The Senate passed the bill on January 24, 1968.
The bill was signed by Governor George C. Wallace on January 25, 1968.
The bill became effective on January 26, 1968.

when the scale reading was zero degrees. Fortunately, one of the sheets was loose in its frame and could not be tightened. This was used as the polarizer. A diametrically loaded Bakelite ring was placed in the field with the axis of loading vertical. The Polaroid polarizer retaining frame was set at zero degrees on the scale scribed against an index line and the loose sheet rotated with the analyser to bring out the vertical isoclinic in the ring. The polarizer sheet was then fixed in position with respect to the retaining frame by several strips of cellophane tape.

Procedure

The determination of the isoclinics required that the polarizer and analyser transmitting axes be mutually perpendicular and that this relationship be maintained as the polarizer is rotated to produce isoclinics of different parameters. This is the arrangement which produces maximum extinction if no model is in place. The polariser, since it had been set at zero degrees for the vertical direction and was marked in five degree increments to 90 degrees, was felt to be adequate for determining the parameter of the isoclinics. Therefore, to produce any isoclinic, as for example the 30 degree isoclinic, the polarizer was rotated to 30 degrees and the analyser was in turn rotated to produce maximum extinction. The amount of rotation was marked on the retaining ring of the analyser and over a series of runs, from 0 to 90 degrees, it was found that the analyser rotation, as judged by observing the point of maximum extinction, was reproducible within one-half of a degree for any angle and, in general, was better than that. Therefore, to reduce the time required to take cuts, the analyser setting was marked and used without further check for each angle.

admits not to the circumstances which may give birth to such
an asocial and anti-social conduct as often occurs in the case of
boys and girls who have been deprived of normal family life, or
of parents who are unable to fulfil their responsibilities. The
parental responsibilities of the father are not so clear as those of the
mother, and the father's attitude towards his wife and children
is often very difficult to determine. The father's social and
moral influence on his wife and children is frequently very
great, and it is often known that such influences are of决定性.

approximately one-half tonnage will be required to be carried by each ship
and that the value of cargo per tonne will be approximately twenty-five thousand
dollars. It is proposed that the tonnage be so distributed as to give sufficient
tonnage during the early months of the year, and that the remainder be available
at such time as may be required. The latter will not exceed one-half the total
annual tonnage, and it will be arranged so as to harmonize with
the existing tonnage of shipping. It is proposed also to increase the tonnage
of the tonnage now available, by obtaining some of the surplus not in
immediate use at present, by getting ships and tonnage into the service
thereafter and by purchasing and so fitting up tonnage to harmonize with
the tonnage now in existence or to obtain a more
convenient tonnage to meet the requirements of foreign, 16,000,000 tons
carrying 12,000 days and enough to 12,000-13,000 days. It is proposed that
each ship be fitted out with two engines of 1,000 horse power each
and that there shall be provided two 100-ton coal bunkers and

The models were constructed of 1/4" Plexiglas, a photo-elastic material of low sensitivity. Three aspect ratios were used; namely 5:1, 3:1, and 2:1, based on a common span of 12 inches. The overall span was 14 3/8", there being 1 3/16" clamping area at each end. The stiffeners were, in all cases, 1/4" x 3/4" Plexiglas and these were attached to the model along the shorter axis of symmetry. The stiffeners were "welded" to the plate by soaking the contact edge in the solvent for about five minutes. The solvent was furnished by Forest Products, Inc. of Cambridge, Massachusetts and it is understood that the principal ingredient was ethylene dichloride. The stiffeners were placed in position on the model and pressed with weights to remove any bubbles on the interface. Before it was completely set, a few drops of the solvent were placed on the line of contact formed by the plate surface and the side of the stiffener. These were allowed to run evenly over the entire length and resulted in a fillet as well as removing the effect of any irregularities in the edge of the stiffener.

Each model was marked with a one-inch grid and then placed in the load frame. The models were clamped between two pieces of hot-rolled steel which in turn were clamped by the inner posts of the load frame. It is felt that the clamping bolts were set up uniformly at about 10 pound-feet torque and that the tension in the bolts was about 1500 pounds. The bolts were set up with a socket wrench which had a 10-pound weight attached at the end.

The square grid was used to determine the amount of distortion in the system and to aid in positioning the model in the field to assure complete coverage. Due to the distortion in the lens system, it was necessary to reposition the model at least four times to adequately cover

half the model. If it had been possible to correct the "pin cushion" distortion resulting from non-uniform magnification, the amount of time required would have been cut in half and the accuracy of the data increased considerably.

The load was applied to the model by a 1/2" diameter load point, acting on the plate through a 3/16" diameter load pin. The axis of the load pin was normal to the plane of the plate. The load pin and pointer were accurately aligned over the plate to insure two-dimensional stress distribution. For the same reason, the load did not bear on the stiffener, for the stiffened models. The weight of the weighing tank by itself was found to be sufficient to produce isoclinics in all the models. Further loading seemed to sharpen the isoclinics and for the sake of uniformity, a load of 400 pounds was used. Water was added to the weighing tank by operating the three-way valve, which was located at the strain indicator.

Using white light, the isoclinics were determined at ten degree increments from 0 to 90 degrees and at 45 degrees. The 90-degree isoclinic coincides with the 0-degree isoclinic and was used as a check point. Similarly, the 45-degree isoclinic is symmetrical about the axis of symmetry for a model loaded on the axis of symmetry and this isoclinic was used to check the symmetry of loading as well as the accuracy of the zero-setting of the polarizer.

C. DESIGN AND CONSTRUCTION OF THE LOAD FRAME

Considerations

There are several requirements for any loading system and these might be loosely sub-divided into those peculiar to the particular system and those which apply regardless of how the load system is to be used. The loading frame which was designed and constructed incident to this thesis was envisioned as an addition to the equipment of the Ships Structure Laboratory, Massachusetts Institute of Technology, and for this reason, greater attention to detail was given than would otherwise be the case for such a small thesis. The considerations which were entertained are listed below. Some of these requirements have not been met in the sense that modifications or additions not absolutely required for this particular thesis have not been made.

1. The load frame must be able to apply either tension or compression.
2. Application and removal of load must be smooth.
3. The applied load must be easily reproducible.
4. The calibration of the load frame should be simple and direct reading.
5. The loading and the model must be maintained in a position normal to the axis of the light.
6. Deflection of the load frame should be of at least one order of magnitude lower than that expected in the model in order that deflection of the model is not influenced sensibly by deflection of the frame and that the direction of loading does not change.

7. The frame must be able to adjust easily to different sizes and shapes of models.

8. Remote loading from the viewing position of the polariscope is highly desirable.

9. Horizontal and vertical movement of the frame is necessary to accurately position the model.

Description

Figure I is the original plan of the loading frame, designed to produce a concentrated load of 1500 pounds at the load pointer. The existing design differs in small details from the drawing; the most prominent of these is the increased height of the vertical posts. These have been increased in length to 30 inches. There is indicated on the plan a system for maintaining the upper and lower edges of the models in a plane. This scheme was abandoned from economic considerations since it was not entirely certain that it would be required.

The vertical posts of the load frame are 3" x 0.258" structural aluminum channels. Calculations indicated that the pivot pin reaction would not exceed 1000 pounds and that the deflection of the outer posts would therefore not exceed 0.0053 inches. It was felt that it was necessary to remove the effect of this deflection from the model supports, especially since the deflection is not symmetrical. For this reason, the inner posts were added for the purpose of retaining and supporting the model. The 3/4" holes in the outer posts are spaced 2 inches apart, the holes in one pair being 1 inch lower than the other pair. This permits adjustment of the height of the loading beam in 1-inch increments.

The steel pivot pin, about which the loading beam pivots, is supported by two brass bushings in the 3/4" holes mentioned above. The

Invitation of guests invited by the author from abroad will be

subject to whom the author will be

advised by the author, provided that such guests remain at

the author's expense, and that the author will be responsible for their

lodging, meals and the expenses incurred by the author.

Lodging and meals, however, will

not be provided for guests invited by the author, unless the author has so

arranged with the author, or the author has so arranged with the author.

It is understood, however, that the author will be liable for expenses of a reasonable

amount, which may be incurred by the author in connection with the author's lodgings

or meals, if the author fails to provide lodgings or meals for the author.

It is further understood that the author will be liable for expenses of a reasonable amount

incurred by the author in connection with the author's meals, if the author fails to provide

lodging or meals for the author, or if the author fails to provide lodgings or meals for the author.

It is further understood that the author will be liable for expenses of a reasonable amount

incurred by the author in connection with the author's meals, if the author fails to provide

lodging or meals for the author, or if the author fails to provide lodgings or meals for the author.

It is further understood that the author will be liable for expenses of a reasonable amount

incurred by the author in connection with the author's meals, if the author fails to provide

lodging or meals for the author, or if the author fails to provide lodgings or meals for the author.

It is further understood that the author will be liable for expenses of a reasonable amount

incurred by the author in connection with the author's meals, if the author fails to provide

lodging or meals for the author, or if the author fails to provide lodgings or meals for the author.

It is further understood that the author will be liable for expenses of a reasonable amount

incurred by the author in connection with the author's meals, if the author fails to provide

lodging or meals for the author, or if the author fails to provide lodgings or meals for the author.

It is further understood that the author will be liable for expenses of a reasonable amount

incurred by the author in connection with the author's meals, if the author fails to provide

bushings are a light press fit in the holes and were felt to be necessary to prevent elongation of the holes in the aluminum channels with resulting loss of accuracy. Deflection of the steel shaft is calculated at 0.002 inches, taking account of shear deflection and assuming simple support in the bushings.

The load beam is fitted with a Norma-Hoffman R312-LB roller bearing rated at 2910 pounds load at 25 revolutions per minute. This is obviously better performance than is required, but several considerations dictated its selection. It was desired to keep the spacing of the vertical posts at about 1/2 inch in order to reduce the shims required to clamp a 1/4-inch model. The load pointer would be centered in the post spacing and therefore the bearing should not exceed the thickness of the beam, which was limited by the post spacing. In addition, it was recognized that the loading beam would be the critical part of the load frame, due to this limitation on its thickness, and therefore the diameter of the bearing should be as small as possible. Ball bearings, which would be preferable from the low-friction consideration, are not available under these limitations.

The maximum moment anticipated in the loading beam is 16,100 pound-inches and the maximum flexure stress is 31,000 pound per square inch. The beam is 24S-T4 alloy and the yield strength of this material is 43,000 pounds per square inch. Ultimate strength is 68,000 pounds per square inch. These figures indicate a rather high stress level and investigation of the deflection to be expected shows that it will be about 1.00 inches at the free end. However, investigation and experience has shown that loads of over 1000 pounds are seldom required and that

protection of their rights and interests in all areas such as the environment
and labour law. Although economic and social rights are not explicitly enshrined
in the constitution at this stage and is intended, attempts to assi-
st people with disabilities and their families to exercise these fundamental
rights and
protect their human rights and dignity at the same time will still
involve a lot of work and effort on the part of the local community to identify
individual circumstances, interests and characteristics of their surrounding settled
areas. In addition, it is necessary and good to establish an effective mechanism
and a system of feedback among the members of the local community so that they can
be fully involved, but the members of their society, but it will also have
other good and fair standards and norms for them to follow and to evaluate
and judge each other on the protection of human rights and to ensure that
all of the human rights are not violated and no discrimination
exists and to establish and maintain the principles of equality and non-discrimina-
tion among the members and citizens and to facilitate the implementation
of the principles of equality and non-discrimination in the administration of justice and
the protection of human rights.

in general, an upper limit of 500 pounds might be accepted. In service, therefore, the probable deflection will be about 0.30 inches.

The cross feed mechanism was made up by the Ace Machine and Tool Company of Cambridge, Massachusetts from sketches furnished by the writer and no formal drawings are available for presentation. Figure V, however, shows the roller bearings and hold-down mechanism as well as the lathe screw used to move the bed plate and loading frame across the field of the polariscope. Steel bearing strips are attached on the under side of the bed and the rollers bear directly on these. They were felt to be necessary since the bed plate is of "O" temper aluminum, the hardness of which is only about 23 Brinnell.

The requirement for smooth loading was met by adoption of a hydraulic loading system. This consisted of a 56-gallon tank which was suspended from the loading beam by a slider identical in form to the one used to load the model. The tank is open at the top end and is fitted with two sill cocks at the bottom. Water is added or removed from the tank by a three-way valve and system of hoses connecting with the city water mains. The three-way valve is located at the viewing screen and may be seen in Figure II. In the "Load" position, water is admitted to the tank directly through the valve. In the "Unload" position, water is directed to an ejector, which in turn removes water from the tank at about 2.5 gallons per minute. The ejector is a commercial device used to drain home washing machines. It operates by a reduction in pressure resulting from flow through an orifice, and represents the least expensive and most trouble-free type of pump available.

Direct measurement of the load is achieved by use of the SR-4 Type A-7 electric strain gage. The load pointer is cylindrical except for two

and from all directions of life, is moving out to find scope in, finding in
books and drama and like educational activities in, returning
to our institutions and so on where we ourselves have come will
make up of additional studies which supplemental, regardless of regular
curricula, will increase the knowledge and skill of our students, making
not as fine as educational institution has ever had before now, because
there will always be a greater variety of subjects and more of their own nature
and scope but no necessarily less scientific and moral instruction and the
whole idea will be to make the school a liberal, free school and free and not to
encourage any particular religion or to fit people and not waste education
and learning in futile and useless ways. The whole idea of doing the
best possible is to provide for you the greatest degree of opportunity and
education and culture and reading, a place where there will always be
as much and as many of every kind of knowledge and of every kind of skill and art
and craft as can be found in any other country in Europe or America, and the schools
will teach them how and what good work can be done, how every person
can serve his time and serve a purpose and do honor to his own particular
elements and to himself as best according to his own taste. It ought
to be however as much as possible, to let each student follow his own
inclination and interest as best he can, and return from the school with
the name of that service impressed in his memory and character, and
not with any memory of criticism or of rebuke. It makes
them more valuable than any other kind of education and especially
when it is given in a spirit of freedom and independence and
with the right kind of teacher, who will help him to find scope in
and to move forward in every way and every other activity. The

small axial flats machined parallel to the keeper groove which holds the 3/16-inch load pin in place. One strain gage is mounted on each of these and placed in opposite arms on an external bridge circuit. Two more gages of the A-7 type are located in the other arms of the bridge and are used for temperature compensation. Figure IV shows the slider, load pointer and load pin in position. The compensating gages are mounted on the flat bar attached at the upper corner of the slider.

The maximum strain in the pointer is 745 micro-inches per inch, under 1500 pounds load. Calibration of the axial gages at their rated gage factor of 1.95 led to constants of 0.49 micro-inches per inch per pound and 0.496 micro-inches per inch per pound respectively for the two gages separately. By operating at a gage factor of 1.92, with the axial gages in opposite arms of the bridge, a calibration of 1.0 micro-inches per inch per pound was attained, leading to extremely simple determination of load magnitude. The external bridge was connected to a Baldwin Type L Strain Indicator and it is estimated that the load is known to within 2.5 pounds over the range, based on the resolution of the strain indicator.

Results

The loading frame has been used only for compressive loads and in this respect it has performed as expected. The method of clamping the model appears to be satisfactory and it is not anticipated that any difficulty will be met in adapting the frame for tensile loads, pure bending or any other type of loading which may, in future work, be required.

The loading beam and water tank have proved to be a satisfactory arrangement. Smooth variation of the load as well as reproducibility have been demonstrated. Deflection of the beam is felt to be excessive

and which would strongly support our position, because many large firms
would be forced to reduce it even more, and would be able to do so much more
easily than small firms. This would therefore be no better strategy for banks than
to force large companies to do more and more of their own work. The only
existing bank which will benefit will simply eliminate its branches and
make use of branches over which management will maintain all the usual busi-
nesses and to manage money over the branches that
remain. Thus, the general trend will be towards smaller and more modern firms

whose leaders would be more likely to understand their money better
because they have been educated more. This is also true of the 2000. To prevent
anyone from getting too much power, however, one must not exceed a limit of 400,000
euros per year and not too much money, because they don't want to exceed a limit of 400,000 euros
per year. Below this limit, there is no need to do anything else. This is because
there are no branches and the branches are limited to one or two or three or four
branches in each city, which is sufficient to cover the needs of the local market.
Therefore, the branches of banks will have to limit themselves to 1000 euros per year
for each branch and to collaborate with the local regions and two

REGIONS

as well as local governments and other local, regional and national government
and enterprises to manage over 1000 euros in branches, and to follow their
strategies for their branches. This is the continuation of the strategy taken
by banks who have already taken a lot of branches and have not yet
done so much. Therefore, it would be better for them to do so if they can
keep their branches at a low level, with small towns and small villages and
rural areas where there is less competition and less risk. This is because
the branches of banks are not yet fully developed and have not yet
been established in the rural areas, while towns and small villages are
fully developed and have a good level of development. This is because
the branches of banks are not yet fully developed and have not yet

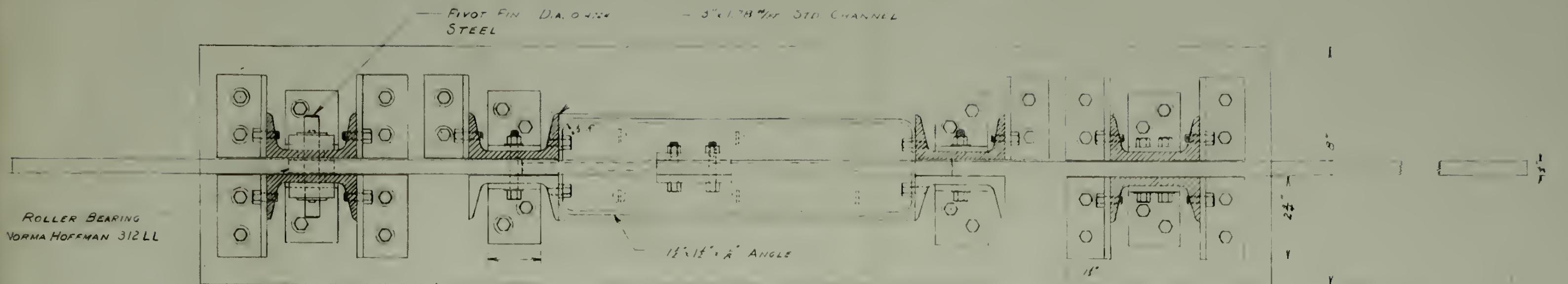
and it is difficult to achieve zero load, due to the weight of the tank and beam. The load pointer has been very satisfactory and represents an improvement over several loading frames described in the literature in that calibration of the tank is not necessary. In addition, it is not necessary to determine the load as a function of the lever arm of the tank.

Recommendations

Probably the most significant change which might be made in the load frame is in the lead beam and water tank, in order to facilitate achieving zero load and reduce the deflection of the beam. The size of the tank could be reduced to thirty gallons or less and thus cut its weight nearly in half. The use of steel for the beam would reduce the deflection by about one third, but at the cost of some of the weight gained by reduction of the size of the tank. Counter balancing of the tank would then be practical and zero load could be achieved.

and not to judge odd or not good oral hygiene or cleanliness at all because
anyone can grow bacteria from just one tooth, even off, and the
problem is a bacterial mouth disease. There are bacteria as
well as oral bacteria in your mouth so it's not just the oral bacteria that is
not to worry but the overall mouth of oral bacteria causing you

to feel bad about your teeth again. There are many
different types of bacteria in your mouth and each will affect your teeth
in different ways and the bacteria that cause tooth decay and gum disease
are just two types that are causing damage to your teeth and your
overall health. So if you have any questions about your teeth or your
overall health, ask your dentist and they will be able to tell you what you
need to do to keep your teeth healthy and your body healthy.



NOTES
 1 MATERIAL ALUMINUM
 EXCEPT AS NOTED
 2 BOLTS ARE $\frac{1}{2}$ " 20NC-2
 EXCEPT AS NOTED

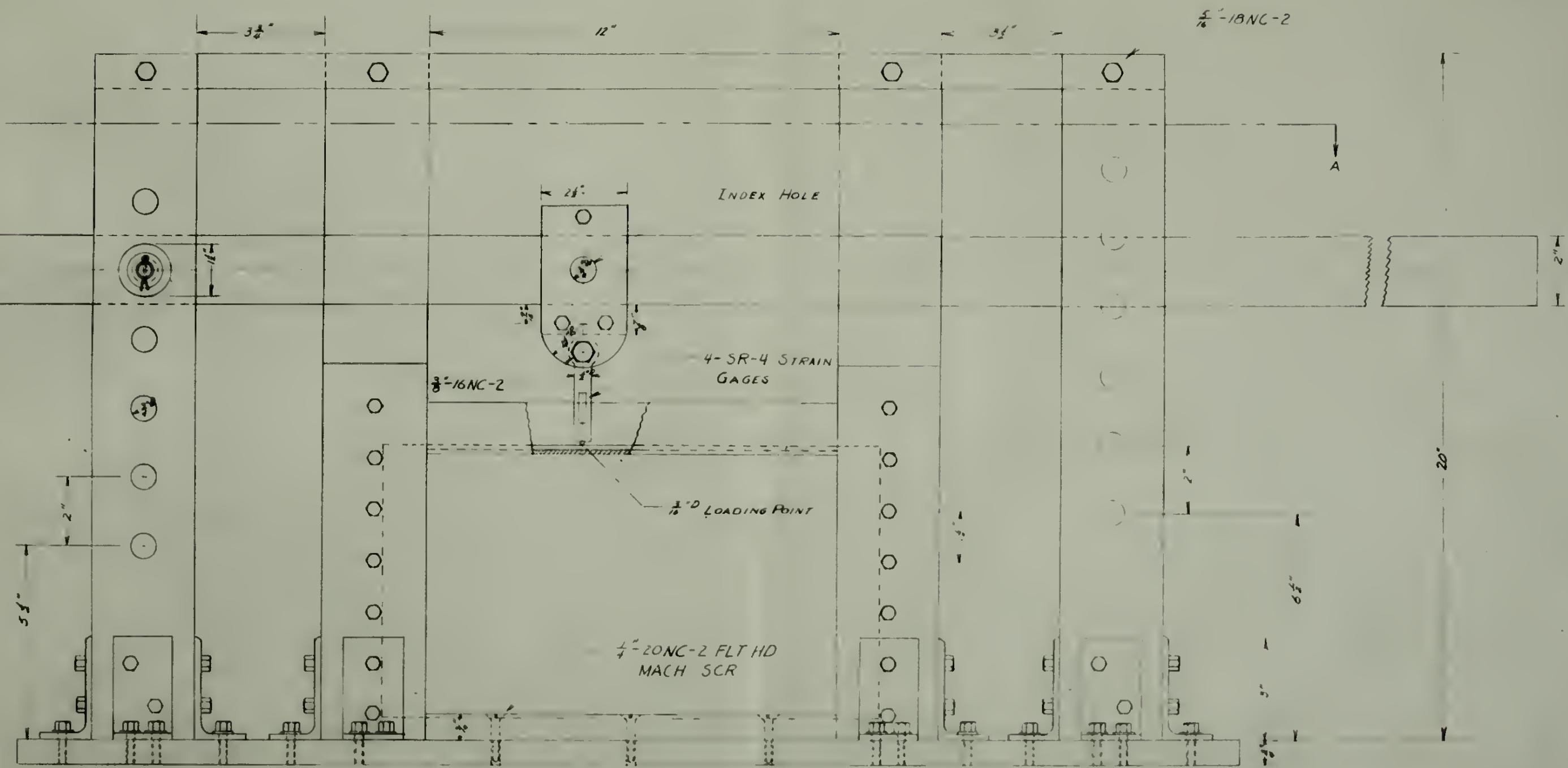


FIGURE I
ELEVATION VIEW OF LOADING JIG

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FIGURE II

General View of the Polariscops and Lead Frame

Note the three-way valve in the foreground, close to
the viewing screen and the strain indicator.

1200 JOURNAL

и сюда докладчик приехал из Краснодара для участия в заседании Технической комиссии по вопросам строительства.

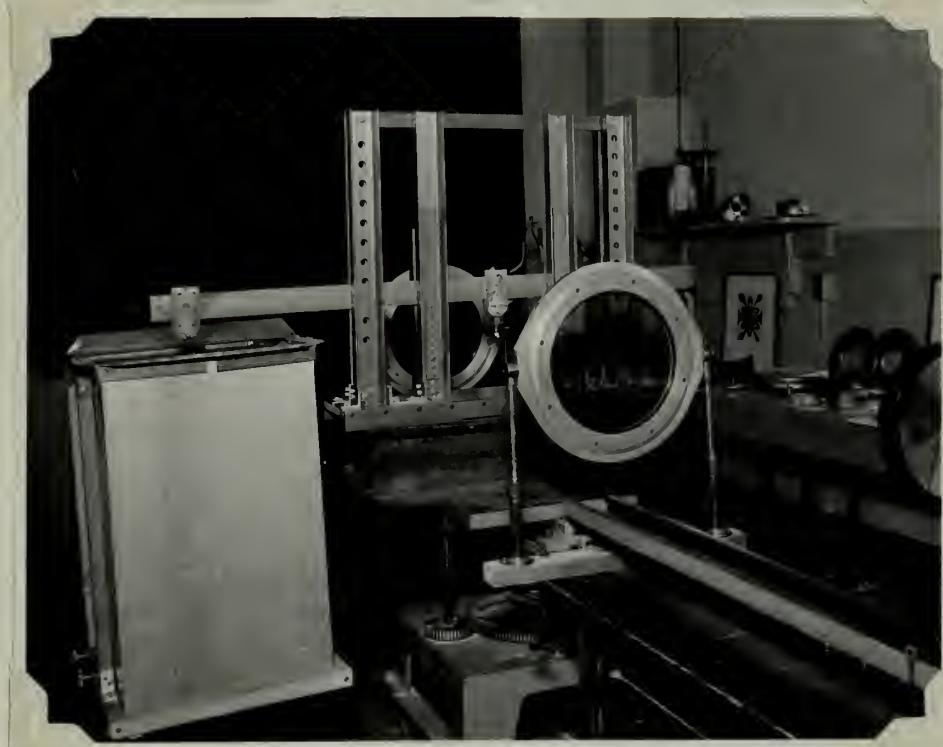


FIGURE III

Load Frame and Weighing Tank

111. 88845

new England boxwood

the new England boxwood
is a small evergreen tree or shrub
with dark green leaves and white flowers.



FIGURE IV
View of Lead Pointer and Pin

Note the dummy compensating strain gage strip and the method of clamping the model.

97 AUGUST

AM has suddenly had to make

an abrupt & permanent change of address
from the city to the country and back again

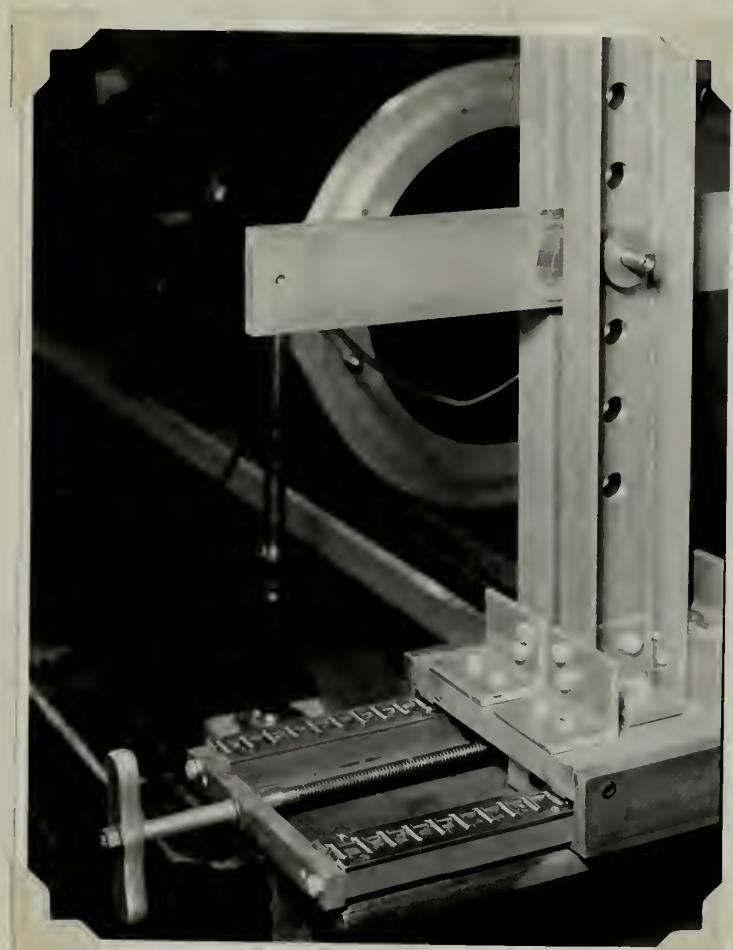


FIGURE V

View of Creasefeed Mechanism

Note the rollers and the hold-down clips, which keep the bed plate against the rollers under the moment of the applied load.

V 20025

reduced duration of the wave

of the pulse which was due probably to the
decrease in the number of ions due to their
loss during the decay.

APPENDIX D.ORIGINAL DATA

ALLEGORIA
ATRI ALLEGORIE

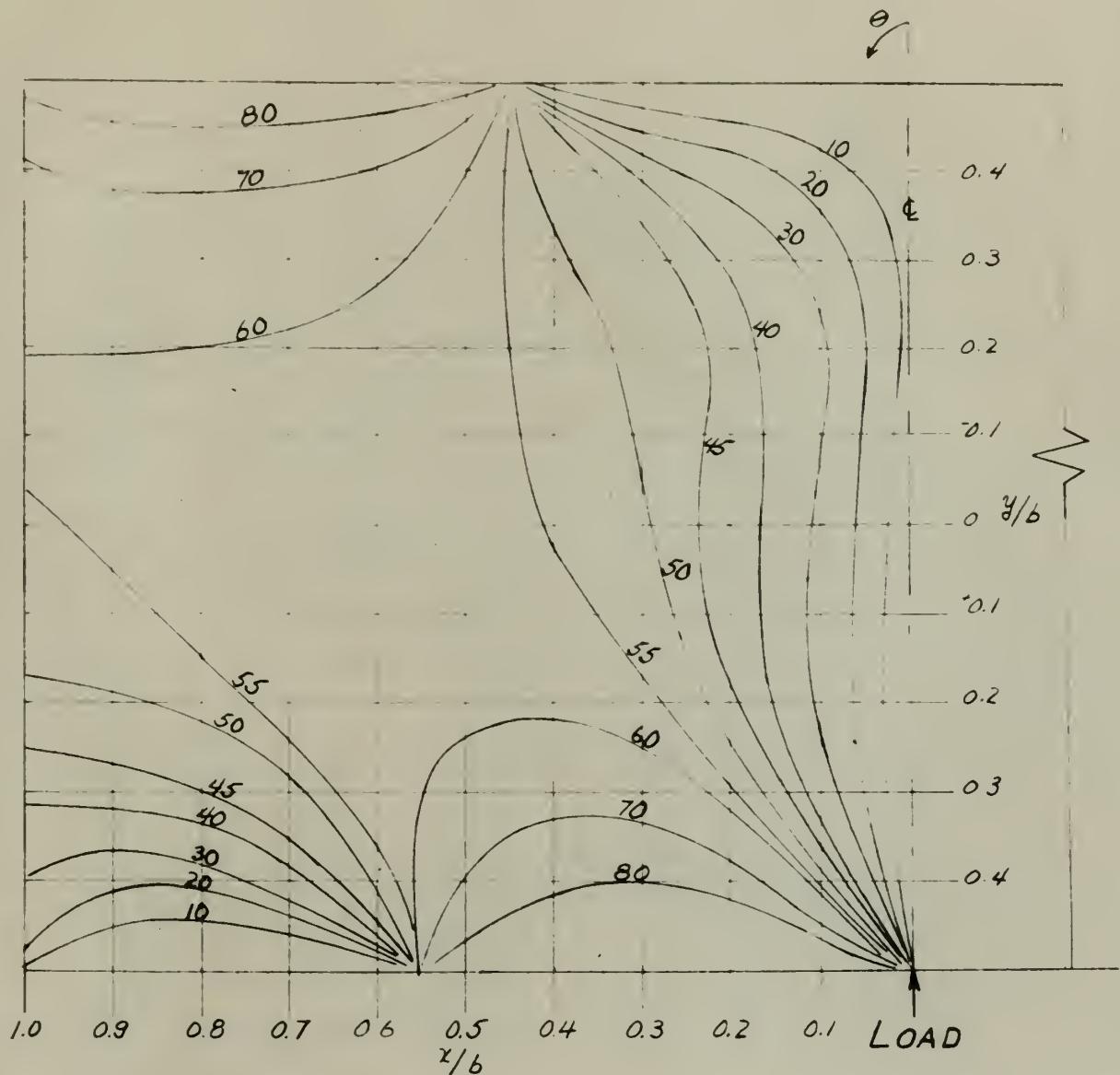


Figure VI (a)
ISOCLINIC PATTERN
Aspect Ratio 2:1
Unstiffened Plate

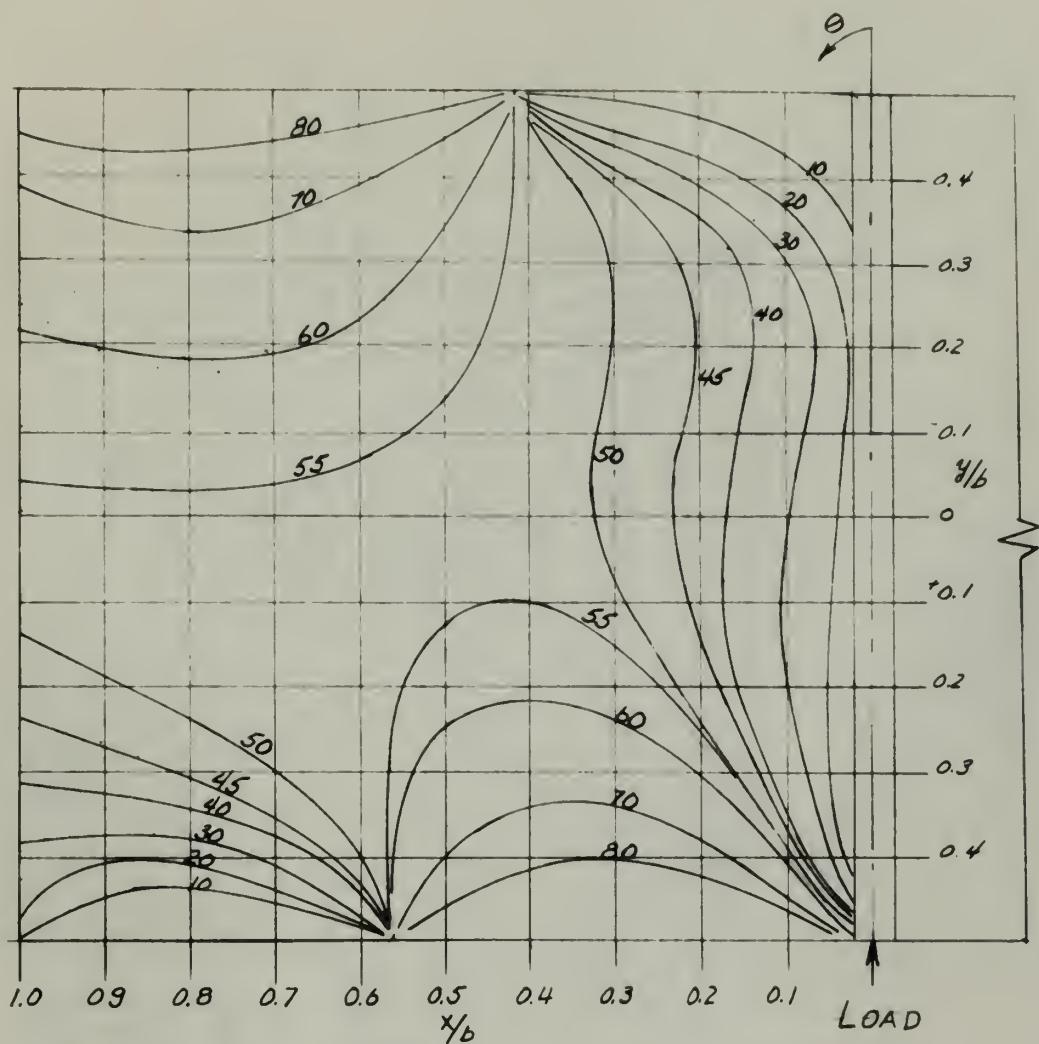


Figure VI (b)
ISOCLINIC PATTERN
Aspect Ratio 2:1
Stiffened Plate

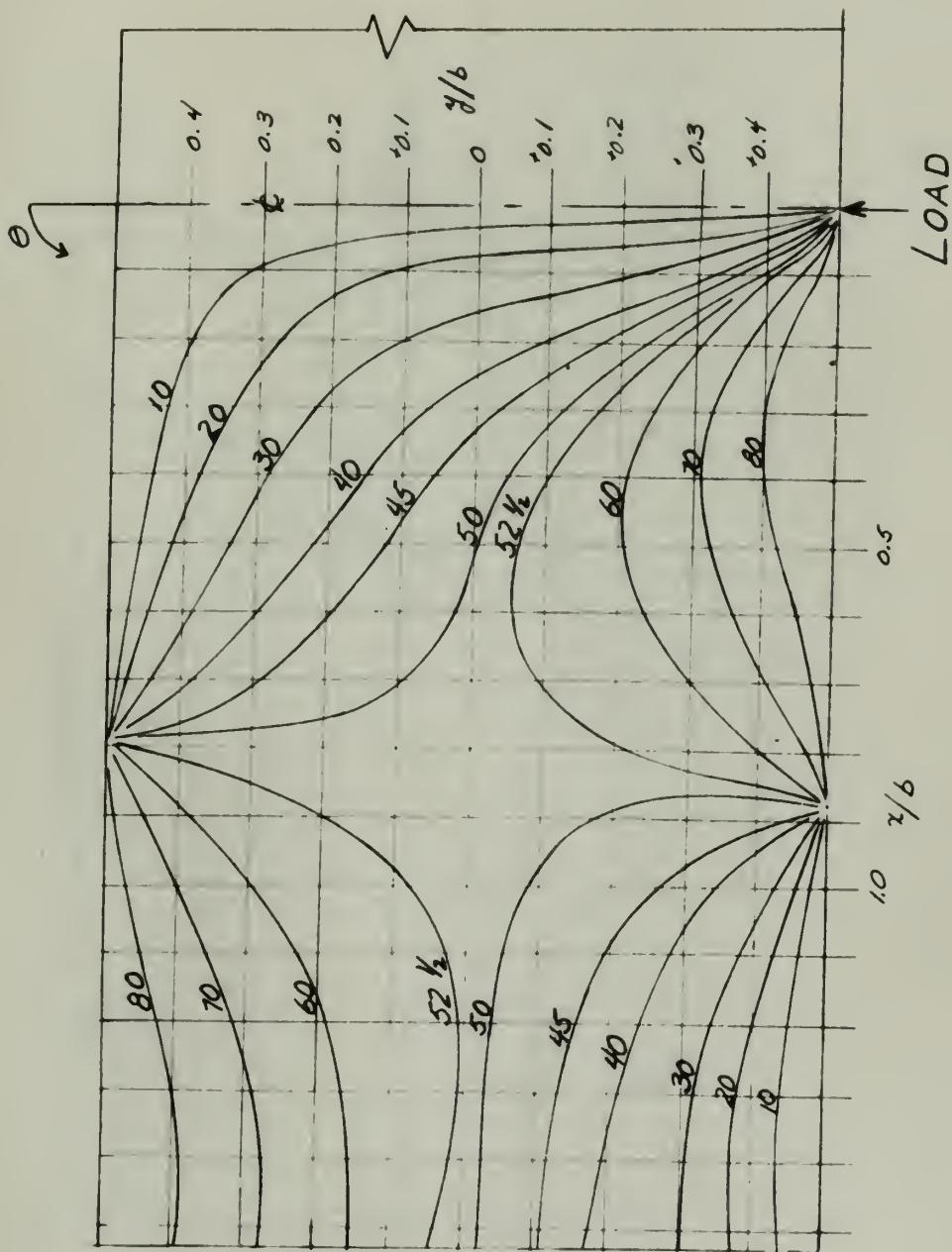


Figure VII (a)
ISOCLINIC PATTERN
Aspect Ratio 3:1
Unstiffened Plate

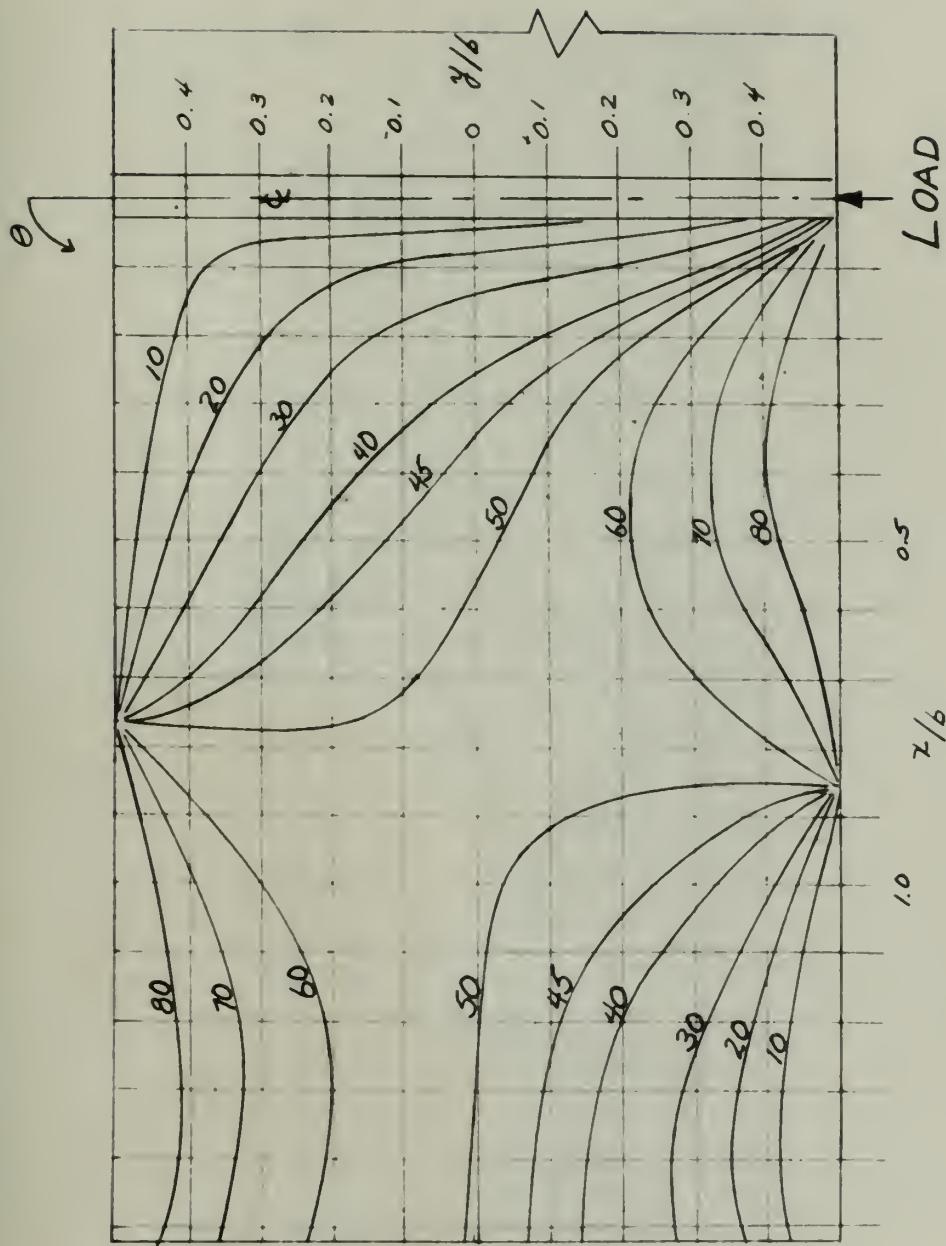


Figure VII (b)
ISOCLINIC PATTERN
Aspect Ratio 3:1
Stiffened Plate

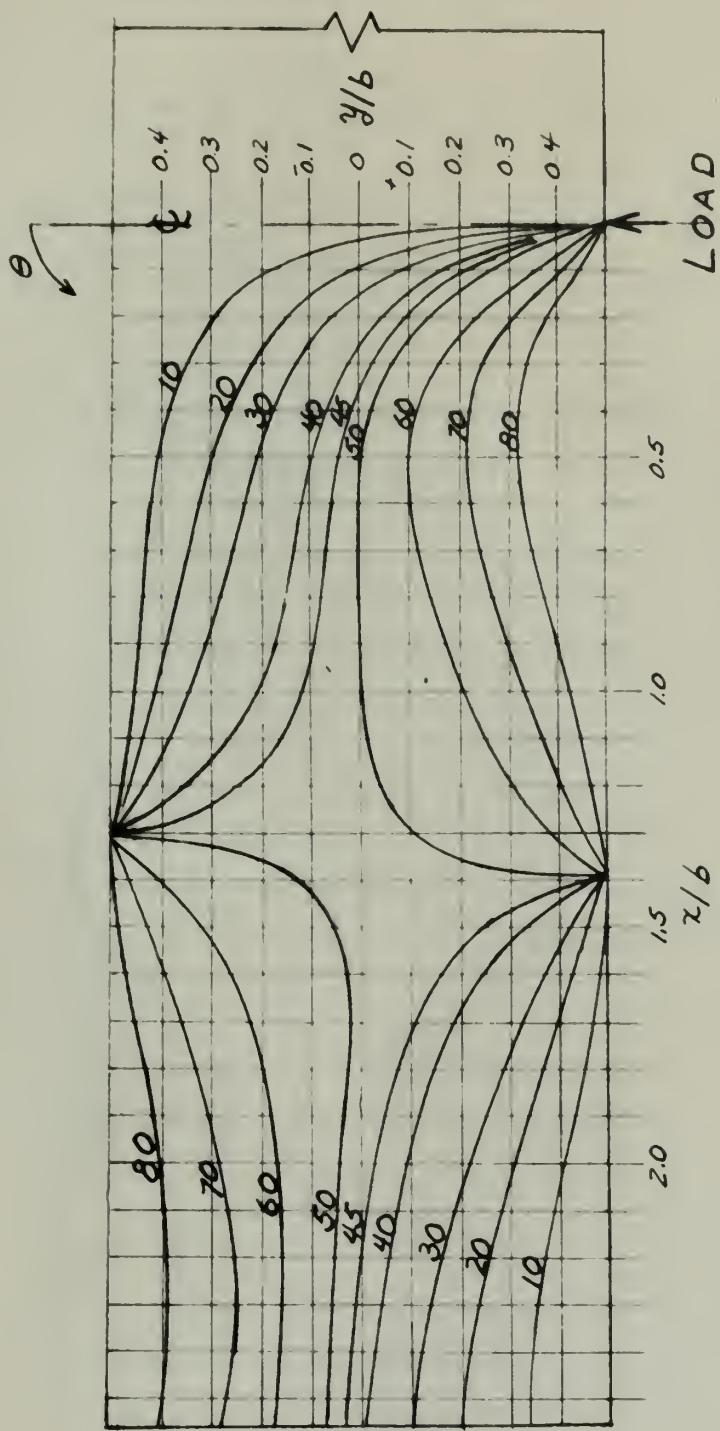


Figure VIII (a)
ISOCLINIC PATTERN
Aspect Ratio 5:1
Unstiffened Plate

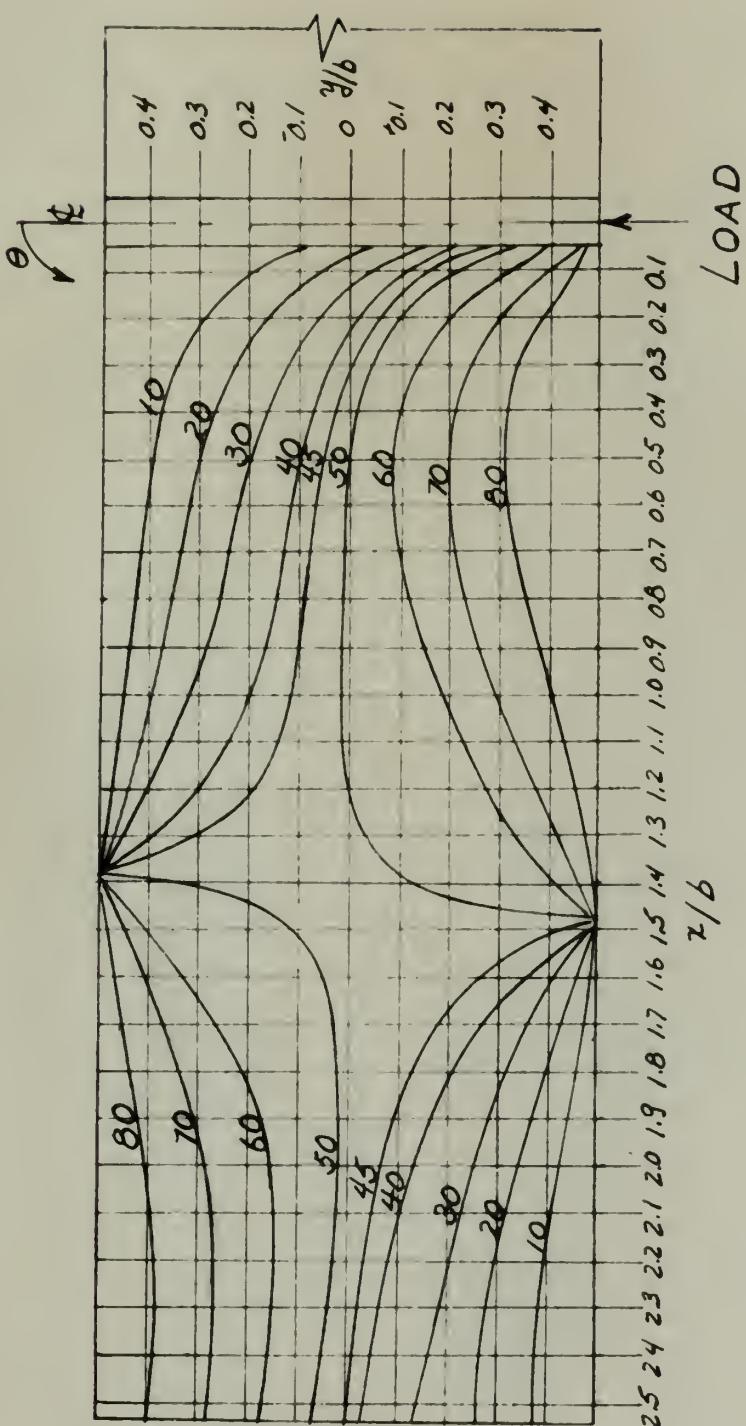


Figure VIII (b)
ISOCLINIC PATTERN
Aspect Ratio 5:1
Stiffened Plate

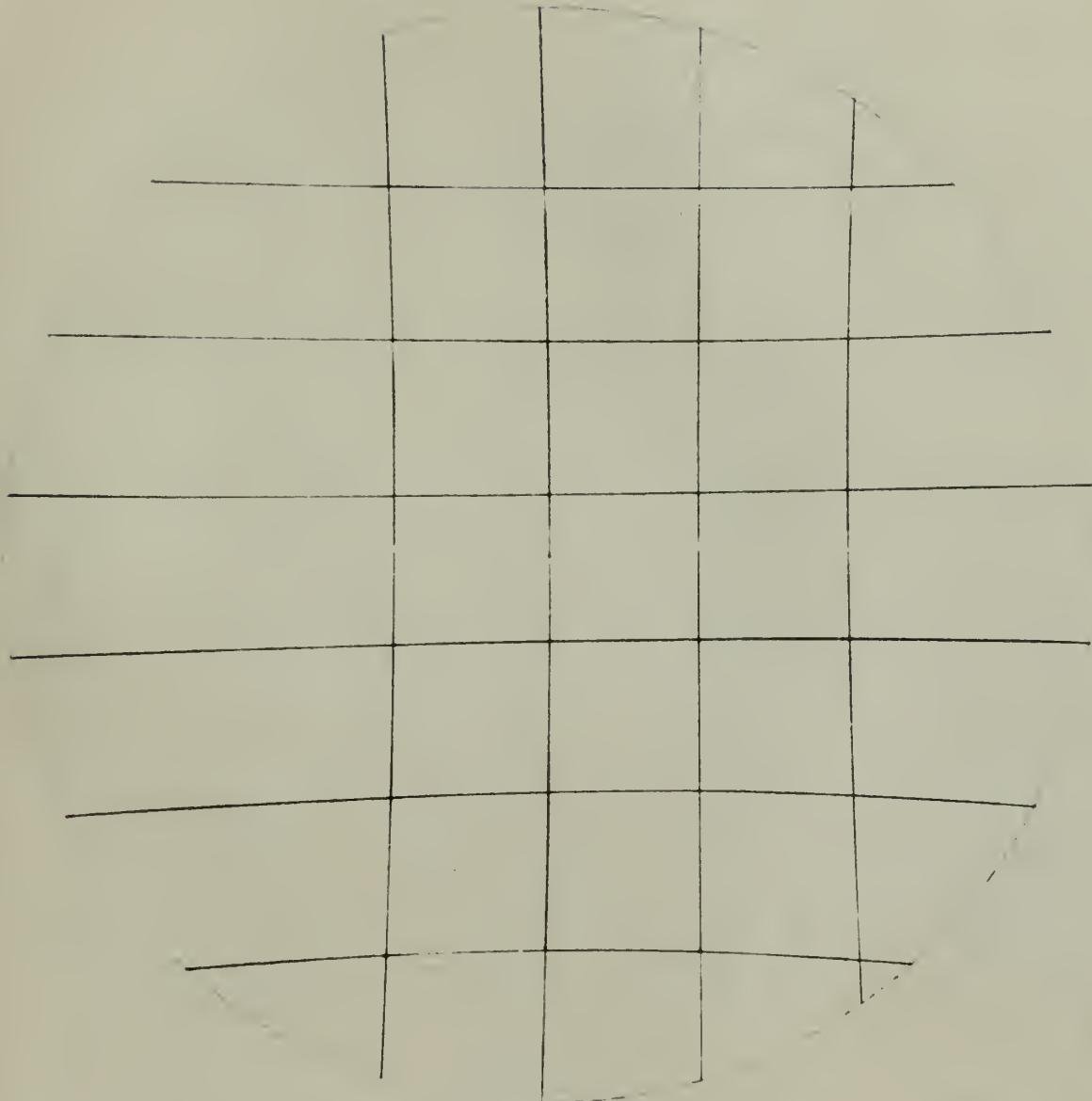


Figure IX
DISTORTION PATTERN
of
One-inch Square Grid

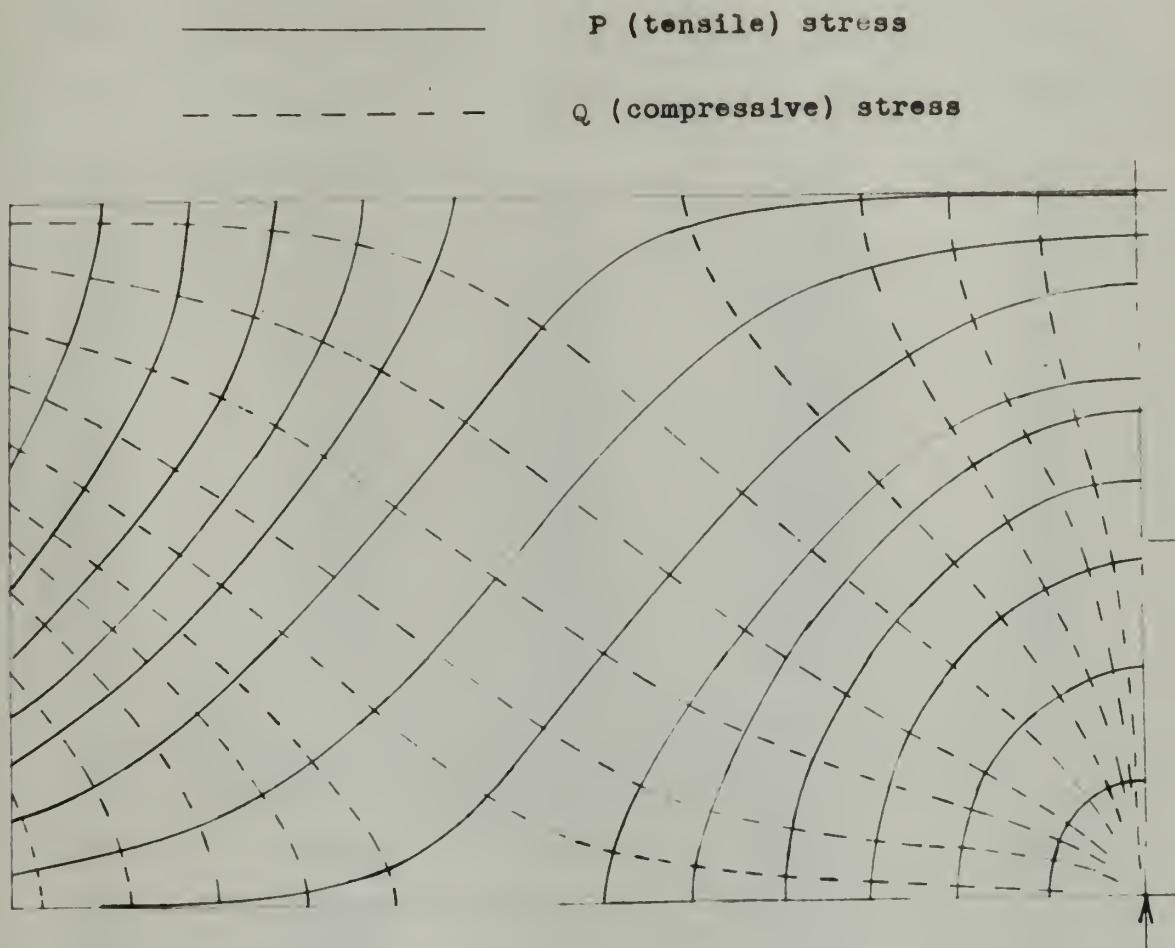


Figure X

STRESS TRAJECTORIES
Aspect Ratio 3:1
Unstiffened Plate

TABLE I

Calibration of Load Pointer

Gage: A-2; axial gage; Type A-7; G.F. 1.95

Load	Reading	Diff.	Reading	Diff.
0	6-0095	0	6-0085	0
100	6-0040	55	6-0038	47
200	4-1984	111	4-1980	105
300	4-1935	160	4-1930	155
400	4-1890	205	4-1880	205
500	4-1835	260	4-1840	245
600	4-1783	312	4-1790	275
700	4-1735	360	4-1745	340
800	4-1690	405	4-1635	390
900	4-1640	455	4-1650	435
1000	4-1590	505	4-1600	485
1100	4-1540	555	4-1550	535
1200	4-1495	600	4-1500	585
1300	4-1445	650	4-1452	632
1400	4-1395	700	4-1410	675
1500	4-1350	745	4-1360	725

Gage: A-1; axial gage; Type A-7; G.F. 1.95

Load	Reading	Diff.	Reading	Diff.
0	6-0310	0	6-0305	0
100	6-0260	50	6-0250	55
200	6-0220	90	6-0200	105
300	6-0170	140	6-0150	155
400	6-0125	185	6-0100	205
500	6-0080	230	6-0040	265
600	6-0030	280	4-1990	315
700	4-1980	330	4-1940	365
800	4-1940	370	4-1890	415
900	4-1890	420	4-1835	475
1000	4-1850	460	4-1780	525
1100	4-1805	505	4-1730	575
1200	4-1760	550	4-1680	625
1300	4-1715	605	4-1630	675
1400	4-1665	645	4-1580	725
1500	4-1622	648	4-1530	775

LAW

Number of good papers

Year	Number	Date	Number	Total
0	8000-1	0	8000-2	0
1	8000-3	0	8000-4	100
2	8000-5	100	8000-6	200
3	8000-7	100	8000-8	200
4	8000-9	100	8000-10	200
5	8000-11	100	8000-12	200
6	8000-13	100	8000-14	200
7	8000-15	100	8000-16	200
8	8000-17	100	8000-18	200
9	8000-19	100	8000-20	200
10	8000-21	100	8000-22	200
11	8000-23	100	8000-24	200
12	8000-25	100	8000-26	200
13	8000-27	100	8000-28	200
14	8000-29	100	8000-30	200
15	8000-31	100	8000-32	200
16	8000-33	100	8000-34	200
17	8000-35	100	8000-36	200
18	8000-37	100	8000-38	200
19	8000-39	100	8000-40	200
20	8000-41	100	8000-42	200
21	8000-43	100	8000-44	200
22	8000-45	100	8000-46	200
23	8000-47	100	8000-48	200
24	8000-49	100	8000-50	200
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26	8000-53	100	8000-54	200
27	8000-55	100	8000-56	200
28	8000-57	100	8000-58	200
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36	8000-73	100	8000-74	200
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41	8000-83	100	8000-84	200
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58	8000-117	100	8000-118	200
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Year	Number	Date	Number	Total
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56	9000-113	100	9000-114	200
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69	9000-139	100	9000-140	200
70	9000-141	100	9000-142	200
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TABLE I (Cont.)

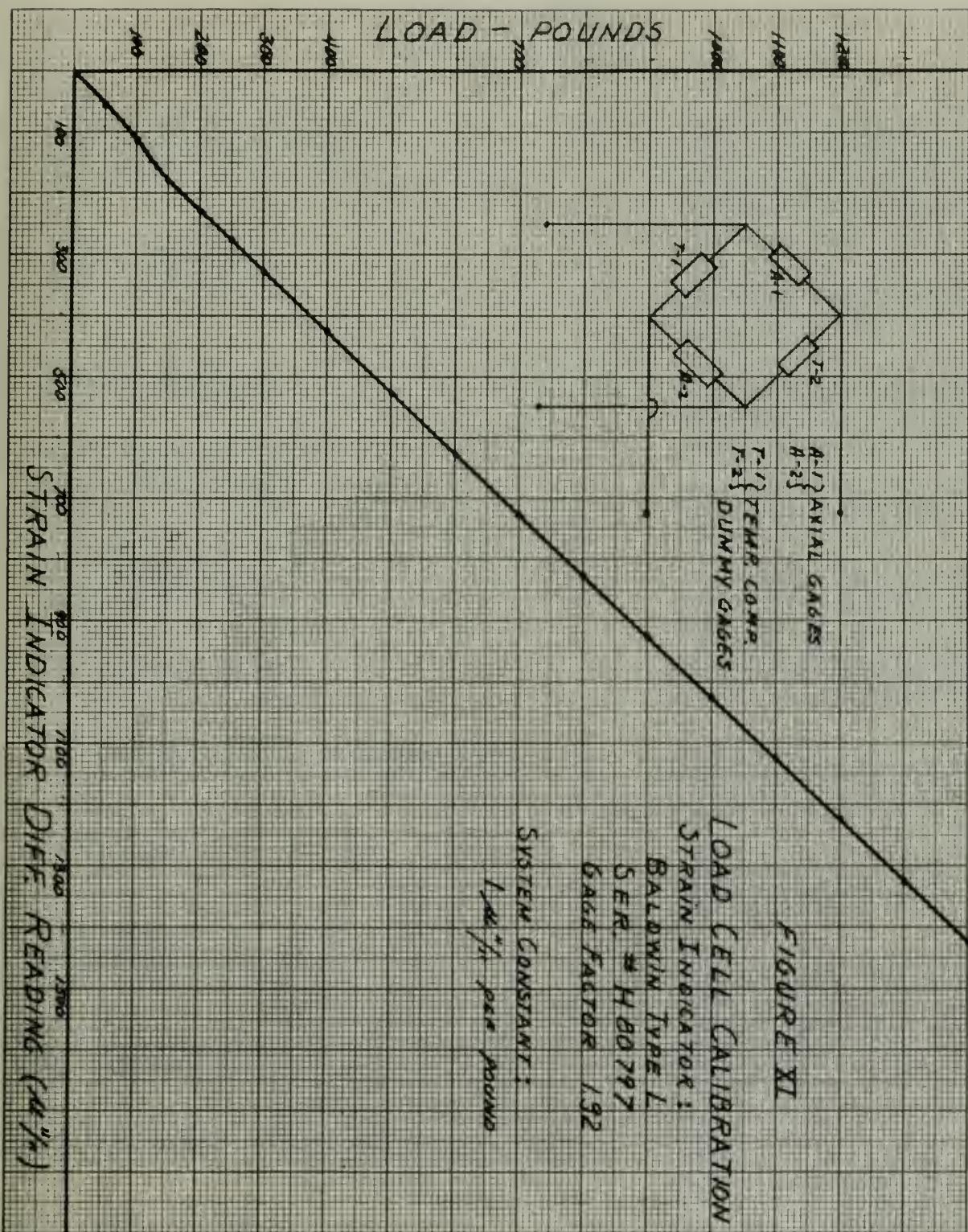
Gage: A-1 & A-2 in opposite arms of bridge; 2 dummy gages
 Gage Factor set at 1.92

Load	Reading	Diff.
0	12-1188	0
50	12-0132	56
100	12-0075	113
150	12-0008	180
200	10-1960	228
250	10-1910	278
300	10-1860	328
350	10-1810	378
400	10-1760	428
450	10-1710	478
500	10-1660	528
600	10-1560	628
700	10-1460	728
800	10-1360	828
900	10-1260	928
1000	10-1160	1028
1100	10-1060	1128
1200	10-0955	1223
1300	10-0860	1323
1400	10-0765	1423
1500	10-0660	1523

(100) L-10002

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IN	10-100-105		097
LA	10-100-106		098
RE	10-100-107		099
IN	10-100-108		100



E. LITERATURE CITATIONS

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- (12) Wang, Chi-Teh Applied Elasticity, New York: McGraw Hill, 1953.

PROBLEMS IN THE FIELD

SUGGESTIONS

- (1) Geology of the Keweenaw Peninsula
G. R. Thompson, C. G. Smith
1921, 116 pp.
- (2) Geology of the Superior Upland
W. H. Dickey (1921)
- (3) Geology of the Superior Upland
W. H. Dickey (1921)
- (4) Geology of the Superior Upland
W. H. Dickey (1921)
- (5) Geology of the Superior Upland
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- (7) Geology of the Superior Upland
W. H. Dickey (1921)
- (8) Geology of the Superior Upland
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W. H. Dickey (1921)
- (11) Geology of the Superior Upland
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